

Q1. Spell out and describe briefly the following essential acronyms associated with the Internet (a hypothetical example: "SNMP = Simple Network Management Protocol, the standard management protocol of the Internet"): [7 Marks]

1. HTTP: Hypertext transfer protocol.
2. SMTP: Simple mail transfer protocol.
3. FTP: File transfer protocol
4. POP: post office protocol.
5. TCP: Transmission Control protocol.
6. ICMP
7. UDP: User datagram protocol.

Q2. Consider the queuing delay in a router buffer (preceding an outbound link). Suppose all packets are L bits, the transmission rate is R bps, and that N packets simultaneously arrive at the buffer every LN/R seconds. Find the average queuing delay of a packet. (Hint: The queuing delay for the first packet is 0; for the second packet L/R ; for the third packet $2L/R$. The N th packet has already been transmitted when the second batch of packets arrive) [3 Marks]

$$\frac{L}{R}, 0 + \frac{L}{R} + \frac{2L}{R} + \dots + (N-1) \frac{L}{R}$$

$$\text{Delay} = \left(0 + \frac{L}{R} + \frac{2L}{R} + \dots + (N-1) \frac{L}{R} \right)$$

$$= \frac{L}{R} (1 + 2 + 3 + \dots + (N-1))$$

$$\frac{n(n+1)}{2} \Rightarrow \frac{(N-1)(N-1+1)}{2} \Rightarrow \frac{N(N-1)}{2}$$

$$\text{Avg delay} = \frac{L}{NR} \left(N \frac{(N-1)}{2} \right) = \frac{(N-1)L}{2R}$$